2

Using Dietary Reference Intakes in Planning Diets for Individuals

SUMMARY

The goal of planning a diet for an individual is to achieve a low probability of inadequacy while not exceeding the Tolerable Upper Intake Level (UL) for each nutrient. The Recommended Dietary Allowance (RDA) or Adequate Intake (AI) is used as the target nutrient intake for individuals, and planners should realize that there is no recognized benefit of usual intakes in excess of these levels. Food-based nutrition education tools are regularly used to help an individual plan a healthy diet. However, as a result of the evaluation of new data regarding nutrient requirements presented in the Dietary Reference Intake reports, some nutrition education tools (e.g., the U.S. Food Guide Pyramid and Canada's Food Guide to Healthy Eating) may require revision to remain current. The DRIs are one of several criteria that should be considered when updating such tools.

Assuming that current nutrition education tools have been evaluated to determine if they are consistent with the new reference intakes for nutrients, individuals who wish to plan nutritionally adequate diets for themselves can review their usual intakes with one of the food guides. Food labels can be used to help choose foods that will make up a healthful diet. Individuals can further plan their intakes to be consistent with dietary guidelines (e.g., *Dietary Guidelines for Americans* [USDA/HHS, 2000], *Canada's Guidelines for Healthy Eating* [Health Canada, 1990a]). Gaps or excesses identified can then be remedied by planning to alter the type or amount of

foods selected from the various food groups, by using fortified foods, or if necessary, by using nutrient supplements.

INTRODUCTION

The Dietary Reference Intakes (DRIs) are used to establish goals in planning diets for individuals. This may include: (1) providing guidance to healthy individuals who are concerned about meeting their nutrient needs, (2) counseling those with special lifestyle considerations (e.g., athletes and vegetarians) or those requiring therapeutic diets, (3) formulating diets for research purposes, and (4) developing food-based dietary guidance for individuals. This chapter focuses on planning diets for normal healthy individuals. Other situations, including planning therapeutic diets, are addressed in Chapter 6.

Planning diets for individuals involves two steps. First, nutrient goals must be set that are appropriate, taking into account various factors that may have an impact upon nutrient needs. Figure 2-1 provides an algorithm for this process. In this chapter the goal for individual planning is to ensure that the diet *as eaten* has an acceptably low probability of nutrient inadequacy while simultaneously minimizing the risk of nutrient excess. This goal is achieved with

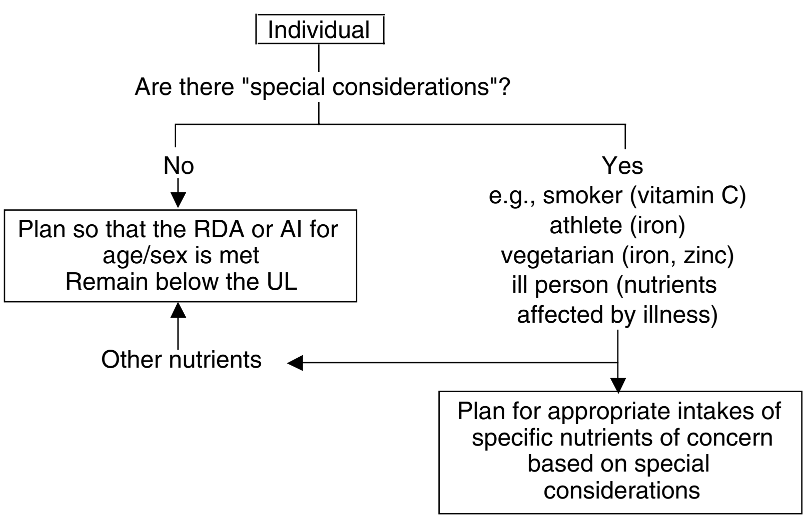

FIGURE 2-1 Schematic decision tree for planning diets for individuals.

diets that meet the recommended intakes (Recommended Dietary Allowance or Adequate Intake) without exceeding the Tolerable Upper Intake Level. Observed intakes may have a high probability of being inadequate or excessive on any given day, but a low probability over time.

When comparing observed intakes to nutrient goals, planners need to be conscious of the errors associated with brief assessments of dietary intake. It is very difficult to obtain accurate estimates of individuals' usual nutrient intakes because intakes typically vary so much from one day to the next. Dietary intakes assessed by multiple 24-hour recalls, dietary records, or quantitative diet histories provide the strongest bases for quantitative assessments of nutrient adequacy, but no method is without error. A full discussion of the uncertainty associated with estimates of an individual's usual intake derived from these methods can be found in the DRI report on dietary assessment (IOM, 2000a). Food frequency questionnaires are not recommended for use in assessments of nutrient adequacy because they have not been found to yield sufficiently accurate estimates of individuals' usual intakes of specific nutrients.

The second step in planning a diet for an individual is to develop a dietary plan that the individual will consume. While the art of crafting appropriate dietary patterns and counseling individuals to achieve them is beyond the scope of this report, information is provided on how to use the DRIs to accomplish these tasks.

SETTING APPROPRIATE NUTRIENT GOALS

As explained in Chapter 1, Dietary Reference Intakes (DRIs) consist of four types of reference intakes that are used to assess and plan diets of individuals and groups: the Estimated Average Requirement (EAR), the Recommended Dietary Allowance (RDA), the Adequate Intake (AI), and the Tolerable Upper Intake Level (UL). The EAR is *not* used as a goal in planning individual diets. By definition, a diet planned to provide the EAR of a nutrient would have a 50 percent likelihood of not meeting an individual's requirement, and this is an unacceptable degree of risk for the individual. What follows is an examination of the RDA, AI, and UL as the three reference intakes related to planning diets for individuals.

Recommended Dietary Allowance

A major goal of dietary planning for individuals is to achieve an acceptably low probability of nutrient inadequacy for a given individual. At the same time, the planner must consider whether increasing an individual's intake beyond its customary level will result in any recognizable benefit. At low levels of intake, the probability of benefit associated with an increase in intake levels is high, but as intake levels rise above the EAR, the probability of benefit of an increased intake diminishes. Planning a diet for an individual that is likely to meet his or her requirement for a nutrient is complicated by the fact that the individual's requirement is almost never known. Most individuals have requirements close to the average requirement for individuals of their sex and age, and the best estimate of an individual's requirement is thus the EAR. However, again by definition, half the individuals in a group have requirements that exceed the EAR. Accordingly, an intake at the level of the EAR would be associated with an unacceptably high risk (50 percent) of not meeting an individual's requirement and would not be suitable as a goal for planning. As intake increases above the EAR, the risk of inadequacy decreases from 50 percent and reaches 2 to 3 percent at the RDA. Thus, the probability of inadequacy is very low for individuals with intakes at the RDA. However, the probability that a given individual will benefit from an increase in intake also decreases to the same extent, and is near zero (less than 2 to 3 percent) when intake increases above the RDA.

The new RDAs may be used as the targets for planning nutrient intakes that result in acceptably low probability of inadequacy for the individual. The RDA is intended to encompass the normal biological variation in the nutrient requirements of individuals. It is set at a level that meets or exceeds the actual nutrient requirements of 97 to 98 percent of individuals in a given life stage and gender group. This level of intake, at which there is a 2 to 3 percent probability of the individual not meeting his or her requirement, has traditionally been adopted as the appropriate reference when planning for individuals. It should be noted that selecting this intake level was, and continues to be, judgmental.

When counseling an individual, it is important to consider whether any recognizable benefit will be achieved if the individual's current intake level is increased. The likelihood of recognizable benefit must be weighed against the costs (monetary and otherwise) likely to be incurred in increasing this intake. An intake level could be chosen at which the risk to the individual is either higher or lower than the 2 to 3 percent level of risk that is inherent in the definition of the RDA.

When other levels are chosen they should be explicitly justified. For example, for a woman between the ages of 19 and 30 years, the

RDA for iron is 18 mg, and is set to cover the needs of women with the highest menstrual blood losses. A particular woman might feel that her menstrual losses were light. Accordingly, she may be willing to accept a 10 percent risk of not meeting her requirements, and thus would have as her goal consumption of only 13 mg of iron/day (see Appendix I in the DRI micronutrient report [IOM, 2001]).

Adequate Intake

An AI is set when scientific evidence is not sufficient to establish an EAR and RDA. Under these circumstances the AI is the target that is used for planning individual diets. Although greater uncertainty exists in determining the probability of inadequacy for a nutrient with an AI than for a nutrient with an RDA, the AI provides a useful basis for planning. However, the probability of inadequacy associated with a failure to achieve the AI is unknown. Unlike a nutrient with an EAR and an RDA, it is not possible to select a level of intake relative to the AI with a known probability of inadequacy.

AIs are set in a variety of ways, as described elsewhere (i.e., IOM, 1997, 1998a, 2000b, 2001, 2002a). But in general they are the observed mean or median nutrient intakes by groups of presumably healthy individuals, or they are based on a review of data derived from both dietary and experimental approaches (e.g., the AIs for calcium and vitamin D [IOM, 1997]). Regardless of how an AI was established, intake at the level of the AI is likely to meet or exceed an individual's requirement, although the possibility that it could fail to meet the requirements of some individuals cannot be discounted.

Tolerable Upper Intake Level

A UL also is provided for many nutrients. The UL is the highest level of chronic daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the specified life stage and gender group. In general, intakes from food, supplements, and other sources (such as water) should be planned so that the UL is not exceeded. The UL is not a recommended level of intake, but an amount that can be tolerated biologically, with no apparent risk of adverse effects, by almost everyone. Risk to the individual is minimized by diets and practices that provide levels of nutrients below the UL, and thus when planning individual diets, the UL should not be exceeded.

For most nutrients, intakes at or above the UL would rarely be attained from unfortified food alone. For example, the intake of a 31-year-old woman who consumed 3.0 mg of vitamin B_6 was at the 99th percentile of the intakes from food sources reported in the 1994–1996 Continuing Survey of Food Intakes by Individuals (CSFII) in the United States (IOM, 1998a). Her RDA is 1.3 mg/day, and the UL is 100 mg/day. If this same woman decreased her intake to 1.43 mg/day, it would be similar to the 50th percentile of intakes in the CSFII. In either case, her intake would be above the RDA and well below the UL. Even if she added a serving of a highly fortified cereal that contained 2.0 mg of vitamin B_6 per serving to her intake each day, her usual intake would still be well below the UL.

As reported in the CSFII, few individuals had intakes from foods that exceeded the UL. However, since these data were collected, fortification of foods in the United States has increased. In addition, these data did not capture supplement usage. Therefore, it is probable that current intake levels of vitamin B_6 and other nutrients from food sources alone might be higher than those reported in the CSFII.

Close attention to intake from highly concentrated sources of nutrients, such as highly fortified foods or supplements (particularly high-dose single nutrient supplements or high-potency multiple-nutrient supplements) may be warranted for some individuals. For some nutrients, total intake may exceed the UL, especially if a person consumes large amounts from supplements and also has a high intake from food sources. For example, if the same 31-year-old woman, in addition to her diet (the 99th percentile of B_6 intake of 3.0 mg/day), consumed a high-potency single supplement capsule of vitamin B_6 that provided 80 mg/day, her total intake would be 83 mg/day. This amount greatly exceeds the RDA of 1.3 mg/day and approaches the UL of 100 mg/day. If she consumed two supplement capsules per day, her intake would exceed the UL and she would be at potential risk of sensory neuropathy, the adverse effect used to set the UL for vitamin B_6.

Suppose that the same woman consumed a high-potency single supplement of zinc that provided 25 mg/day in addition to her daily dietary intake of 10 mg. Her total zinc intake would be 35 mg/day, which exceeds the RDA of 8 mg/day and approaches the UL of 40 mg/day. If she also consumed a fortified cereal with 100 percent of the Daily Value for zinc (15 mg), the UL would be exceeded. Careful attention must be given when planning diets for individuals consuming high-dose supplements or multiple sources of fortified foods so that total intake does not exceed the UL. There is no documented advantage to intakes that exceed the RDA or AI for healthy persons.

PLANNING FOR ENERGY INTAKES OF INDIVIDUALS

The underlying objective of planning for energy is similar to planning for nutrients—to attain an acceptably low risk of inadequacy and of excess. The approach to planning for energy, however, differs substantially from planning for other nutrients. When planning for individuals for nutrients such as vitamins, minerals, and protein, one plans for a low probability of inadequacy by meeting the Recommended Dietary Allowance (RDA) or Adequate Intake (AI), and a low probability of excess by remaining below the Tolerable Upper Intake Level (UL). Even though intakes at or above the RDA or AI are almost certainly above an individual's requirement, and thus would have little or no likelihood of benefit, there are no adverse effects to the individual of consuming an intake above his or her requirement, provided intake remains below the UL.

The situation for energy is quite different. The best way to assess and plan for energy intake of individuals is to consider the healthfulness of their body weights (or body mass index [BMI]) because with energy there is an obvious adverse effect to individuals who consume intakes above their requirements—over time, weight gain occurs. This difference is reflected in the fact that there is no RDA for energy, as it would be inappropriate to recommend an intake that exceeded the requirement (and would lead to weight gain) of 97 to 98 percent of individuals. Instead, equations have been developed that reflect the total energy expenditure (TEE) as estimated from doubly labeled water data and associated with an individual's sex, age, height, weight, and physical activity level. The product of these equations is termed an estimated energy requirement (EER) (IOM, 2002a).

Although different equations were developed for normal-weight and overweight individuals, because they are quite similar, it is recommended that the equations for normal-weight individuals be used for all individuals (IOM, 2002a). All equations predict total energy expenditure and, by definition, the intake required to maintain an individual's current weight and activity level. They were not designed, for example, to lead to weight loss in overweight individuals. However, just as is the case with other nutrients, energy needs vary from one individual to another, even though their characteristics may be similar. This variability is reflected in the standard deviation (SD) of the requirement estimate, which allows for estimating the range within which the individual's requirements could vary. Note that this does not imply that an individual would maintain energy balance at any intake within this range; it simply indicates how variable requirements could be among those with similar characteristics.

For example, the equation for the EER (IOM, 2002a) for normal-weight women 19 to 50 years of age is:

$$\text{EER (kcal)} = 354.1 - (6.91 \times \text{age [y]}) + \text{physical activity coefficient} \times (9.36 \times \text{weight [kg]} + 726 \times \text{height [m]})$$

This equation can be applied to a 33-year-old woman, 1.63 m in height and weighing 55 kg (BMI = 20.8 kg/m^2), whose activity is equivalent to walking about 2 mi/day (this level of activity would be categorized as "low active," and the physical activity coefficient for this activity level is 1.12). Her estimated energy requirement would be calculated as:

$$\text{EER (kcal)} = 354.1 - (6.91 \times 33) + 1.12 \times (9.36 \times 55 + 726 \times 1.63) = 2{,}028$$

This value of 2,028 kcal represents the average energy requirement of women with her specified characteristics (age, height, weight, and activity level). The SD of the EER is estimated as 70 percent of the standard error of the fit of the regression equation (IOM, 2002a). In this example, the SD of the EER would be 160 kcal. The range within which a given woman's energy requirement likely falls (e.g., the 95 percent confidence interval) would be 2,028 ± (2 × 160 kcal), or between 1,708 and 2,348 kcal/day.

It should be emphasized that usual energy intakes are highly correlated with energy expenditure. This means that most people who have access to enough food will consume an amount of energy very close to what they expend, and as a result, maintain their weight within relatively narrow limits over reasonable periods of time. Any changes in weight that do occur usually reflect small imbalances in intake over expenditure accumulated over a long period of time. For normal individuals who are weight-stable, at a healthy weight, and performing at least the minimal recommended amount of total activity, their energy expenditure (and recommended intake) is their usual energy intake. This also applies to maintaining current weight and activity level in overweight individuals. Thus, if one knew an individual's usual energy intake, one would plan to maintain it rather than calculate the EER to obtain an estimate. In most situations, however, the usual energy intakes of individuals are not known, so the equations for TEE are useful planning tools.

Using the Estimated Energy Requirement to Maintain Body Weight in an Individual

When the planning goal is to maintain body weight in an individual with specified characteristics (age, height, weight, and activity level), an initial planning estimate for energy intake is provided by the equation for TEE of an individual with those characteristics. By definition the estimate would be expected to underestimate the true energy expenditure 50 percent of the time, and to overestimate it 50 percent of the time, leading to corresponding changes in body weight. This indicates that monitoring body weight would be required when using the equations to estimate individual energy expenditure. For example, if one was enrolling subjects in a study in which it was important to maintain body weight with a specified activity level, one might begin by feeding each individual the amount of energy estimated using the equation for their EER. Body weight would be closely monitored over time, and the amount of energy provided to each individual would be adjusted up or down from the EER as required to maintain body weight.

Planning for Macronutrient Distribution

In addition to planning a diet that meets an individual's energy requirements and has a low probability of nutrient inadequacy and potential risk of excess, an individual's intake of macronutrients (e.g., carbohydrate, fat, and protein) should be planned so that carbohydrate, total fat, *n*-6 and *n*-3 polyunsaturated fatty acids, and protein are within their respective acceptable ranges (IOM, 2002a). For example, consider the 33-year-old, low-active woman discussed previously, who had an EER of approximately 2,000 kcal. The ranges within which her macronutrient intakes should fall are shown in Table 2-1.

DEVELOPING DIETARY PLANS

Once appropriate nutrient intake goals have been identified for the individual, these must be translated into a dietary plan that is acceptable to the individual. This is most frequently accomplished using nutrient-based food guidance systems.

TABLE 2-1 Distribution of Macronutrient Intake Using the Acceptable Macronutrient Distribution Range for a 33-Year-Old, Low-Active Woman

Macronutrient	Acceptable Macronutrient Distribution Range (% of energy)[a]	Range of Macronutrient Intake for Energy Requirement of ~2000 kcal (g)
Carbohydrate	45–65	225–325
Protein	10–35	50–175
Total fat	20–35	44–78
n-6 Polyunsaturated fatty acids	5–10	11–22
n-3 Polyunsaturated fatty acids	0.6–1.2	1.3–2.7
Added sugars	< 25	< 500 kcal

[a] Source: IOM (2002a).

Nutrient-Based Food Guidance Systems in the United States and Canada

Dietary reference standards (e.g., the former Recommended Dietary Allowances [RDAs] in the United States and the Recommended Nutrient Intakes [RNIs] in Canada) have been used to provide food-based dietary guidance in many ways, including through development of national food guides and dietary guidelines for healthy populations and as a basis for information on food and supplement labels. Dietary guidance systems and food composition tables are the most universally accessible sources of nutrition information available to practitioners and laypersons. Practitioners may also use many other sources of nutrition information for individual planning (such as new information in the scientific literature or information on disease prevention from professional associations).

In practice, guidance about food choices, such as the U.S. Food Guide Pyramid or Canada's Food Guide to Healthy Eating, are widely used. These guides recommend that users select the appropriate amount of food for their age, sex, physiological status, body size, and physical activity level from among a range of servings from several different food groups. The intent is that over a period of days to weeks, varied choices within each group allow recommended intakes of nutrients to be attained. The former RDAs and RNIs were two of the major elements from which these food guidance systems were developed; future revisions will undoubtedly consider the new Dietary Reference Intakes (DRIs). Thus, reference standards for nutrients are implicitly used in planning individual diets when food guides are used.

The following sections present a brief summary of the ways that nutrient recommendations have been used in food guides and food labels. Appendix B provides a more detailed description.

Food Guides in the United States and Canada

Both the Food Guide Pyramid (Figure 2-2) and the Food Guide to Healthy Eating (Figure 2-3) are guides for healthy persons to achieve adequate total nutrient intakes from food sources. Adjustments in intakes due to varying requirements (e.g., age, sex, physiological status) are accomplished with these tools by modifying the number of servings consumed. In these systems, foods within a group are assumed to have particular and fairly similar nutrient profiles, and the specified serving sizes are based in part on an amount that would provide comparable levels of key nutrients from

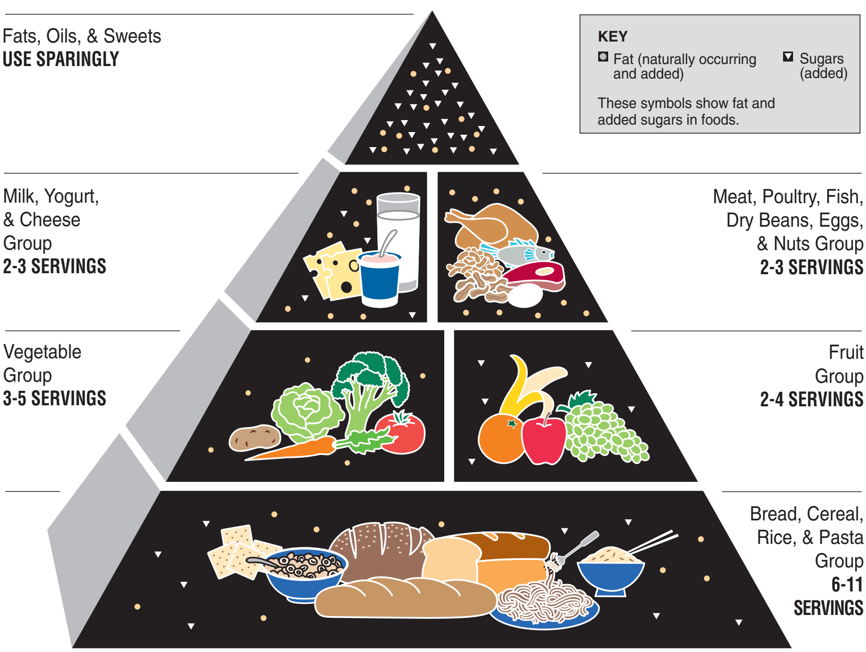

FIGURE 2-2 U.S. Food Guide Pyramid.
SOURCE: USDA (1992).

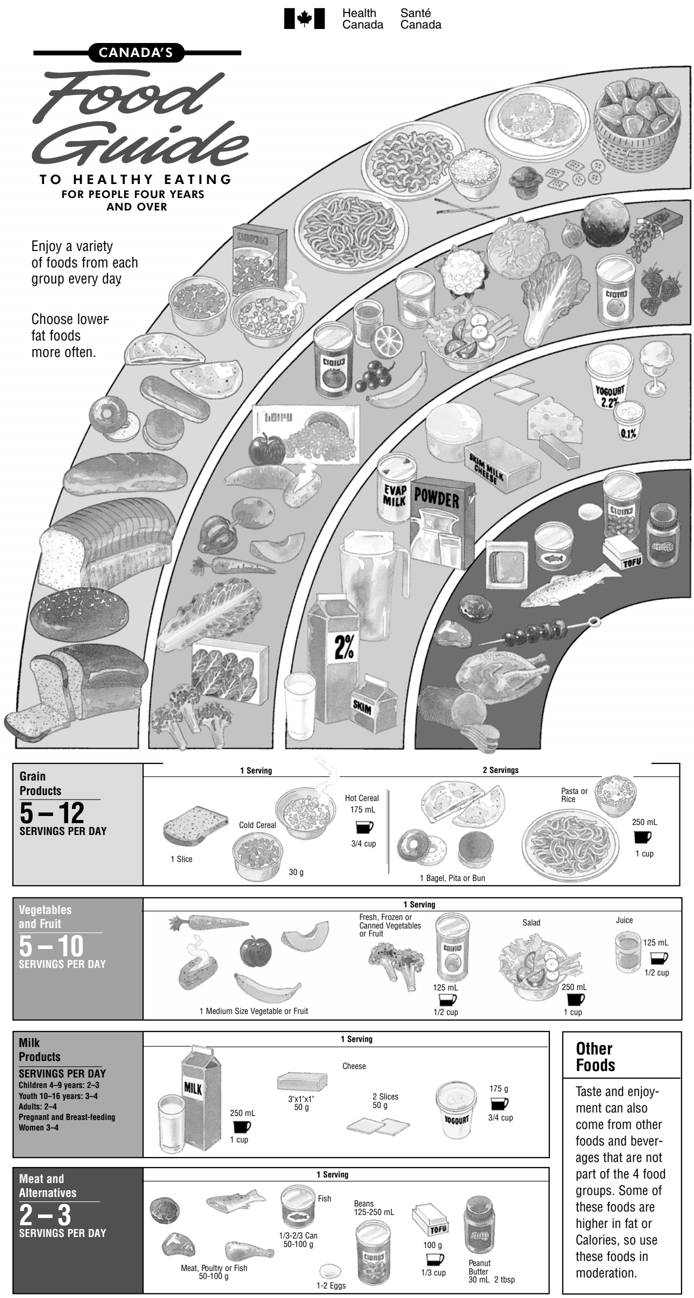

FIGURE 2-3 Canada's Food Guide to Healthy Eating.
SOURCE: Health Canada (1991).

foods within the group. For example, each serving in the "meat and alternatives" group is a good source of protein. One serving of any of the alternatives in this group would have approximately the same amount of protein. As indicated earlier, the design of food guidance systems is that, over a period of time (days or weeks), individuals who consume the recommended number of servings from each food group, and who choose a variety of foods within each group, will obtain the recommended intakes for all nutrients.

As an example, consider an active 22-year-old pregnant woman who receives dietary counseling. Using the Food Guide Pyramid as a guide to achieve the recommended intakes of nutrients, her meal pattern would include a minimum of three servings (7 oz) of protein-rich foods, three servings of dairy products, two servings of fruits, and three servings of vegetables (focusing on foods rich in folate, vitamin C, and β-carotene), and seven servings from the bread, cereal, rice, and pasta group. Additional servings of foods from these groups and from the tip of the pyramid would be added if needed to meet energy requirements. From this the nutritionist would develop a menu plan and an example of food choices based on the above dietary pattern.

Table 2-2 is an example of planning a day's menu using the Food Guide Pyramid. Table 2-3 compares its nutrient content to the current RDAs or Adequate Intakes (AIs) for nutrients. It can be seen that the sample day's menu exceeds intake recommendations for all nutrients, even though it is for only one day. It is important to emphasize that food choices within this menu pattern would vary, and the intake from the one sample day will not accurately reflect the average intake over several days. For example, the average intake of nutrients provided by the sample day's menu in amounts substantially above the RDA could decrease (e.g., the sample menu provides vitamin A in amounts well above the RDA because carrots, a concentrated source of the provitamin A carotenoid, β-carotene, were included). It is expected that varied food choices within the menu pattern would allow average intake to meet recommendations for most nutrients and energy needs.

Those who use food guides to plan menus for individuals must recognize that when new reference intakes for nutrients are developed, there is an unavoidable time lag before the guides can be assessed to determine whether they support the new nutrient reference standards. When new reference intakes have changed considerably from previous standards, a food guide may not be appropriate. For example, the new RDAs for vitamin A (IOM, 2001), while somewhat lower than the previous standards, specify the use of

TABLE 2-2 Sample Planning Menu for a Prenatal Client Aged 22 Years Based on the Food Guide Pyramid

Breakfast	Lunch	Mid-Afternoon Snack	Dinner	Evening Snack
3/4 cup orange juice (FG) 1 cup fortified wheat cereal with raisins (BCG) 1 slice mixed grain toast (BCG) 1 tsp margarine (FSG) 1 tbsp jelly (FSG) 1 cup skim milk (DG)	2 oz tuna fish (PRG) 1 tsp mayonnaise (FSG) 2 slices whole wheat bread (BCG) (with lettuce and tomato) 1/2 cup cooked carrots (VG) 1 glass sweetened iced tea	5 wheat crackers (BCG) 2 tbsp peanut butter (PRG) 1 apple (FG) 1 cup skim milk (DG)	1 cup skim milk (DG) 4 oz roasted chicken breast (PRG) 1 cup cooked long grain rice (BCG) 1/2 cup cooked spinach (VG) 1 cup tossed salad (VG) 2 tbsp low-fat French dressing (FSG)	1 cup yogurt (nonfat) (DG) 1/2 cup fresh blueberries (FG) 1/4 cup dry roasted almonds (PRG)

NOTE: Nutrient analysis was performed using Nutritionist Five, First DataBank, Inc. 2000. FG = fruit group, BCG = bread and cereal group (bread, cereal, rice, and pasta), FSG = fat and sweet group (fats, oils, and sweets), DG = dairy group (milk, yogurt, and cheese), PRG= protein-rich group (meat, poultry, fish, dry beans, eggs, nuts), VG = vegetable group.

retinol activity equivalents (RAE) rather than retinol equivalents (RE) when calculating or reporting the amount of total vitamin A in mixed or plant foods. An RAE gives the β-carotene:retinol equivalency ratio as 12:1, versus the former equivalency of 6:1 (NRC, 1989). The increased ratio means that a larger amount of β-carotene is needed to meet the vitamin A requirement for individuals who rely on plant sources of this vitamin in their diet. Therefore, newer food guides may need to reflect an increase in the amount of darkly colored, carotene-rich fruits and vegetables needed to provide vitamin A in the diet.

Consideration should be given to the new DRIs when food guides are updated. In the interim, dietetic practitioners who plan diets should familiarize themselves with the nutrient intake recommen-

TABLE 2-3 Comparison of Nutrient Intake with Current Recommended Intake, Based on a Sample Planning Menu (Table 2-2)

Nutrient	Planned Intake	RDA or AI for Pregnancy[a]	Planned Intake as % of RDA or AI
Energy (kcal)	2,363	2,365 EER[b]	
Protein (g)	131	71[c]	185
Carbohydrate (g)	320	175	183
Vitamin A (μg RAE)[d]	2,253	770 μg RAE	293
Vitamin C (mg)	140	85	165
Vitamin E (mg α-tocopherol)[e]	15	15	100
Thiamin (mg)	1.9	1.4	135
Riboflavin (mg)	3.5	1.4	250
Niacin (mg)	44	18	244
Vitamin B_6 (mg)	3.0	1.9	158
Folate (μg)	606	600 μg DFE[f]	101
Vitamin B_{12} (μg)	8.2	2.6	315
Calcium (mg)	1,841	1,000	184
Copper (mg)	1.9	1.0	190
Iron (mg)	41	27	152
Magnesium (mg)	649	350	185
Phosphorus (mg)	2,505	700	358
Zinc (mg)	14	11	127

[a] RDA = Recommended Dietary Allowance, AI = Adequate Intake.
[b] Estimated Energy Requirement (EER) = $354.1 - (6.91 \times 22) + 1.27 \times (9.36 \times 54 + 726 \times 1.65) + 0$ (pregnancy energy deposition for first trimester) = 2,365 kcal.
[c] Protein = 46 g/day + 25 g/day of additional protein during pregnancy.
[d] Database values for vitamin A in retinol equivalents (RE) were converted to retinol activity equivalents (RAE). For retinol, 1 RE = 1 RAE. For carotenoids, 1 RE = 0.5 RAE.
[e] Nineteen α-tocopherol equivalents (α-TE) × 0.8 mg = 15.2 mg α-tocopherol, where 0.8 is the ratio of α-tocopherol to α-TE.
[f] 1 μg dietary folate equivalent (DFE) = 1 μg food folate.

dations that have changed substantially, examine existing tools, and modify methods as necessary to ensure that these targets are met.

Fortified Foods

Fortified and enriched foods have the advantage of providing additional sources of certain nutrients that might otherwise be present only in low amounts in some food sources. Therefore, they are helpful in planning diets to reduce the probability of inadequacy of specific nutrients. In addition, they may afford the opportunity to add nutrients in highly bioavailable forms, as is the case with folate- and vitamin B_{12}-fortified foods.

The fortification of foods is undertaken for public health reasons. For example, in the United States and Canada, iodized salt; cereal grains fortified with thiamin, riboflavin, niacin, iron, and folate; and vitamin D-fortified milk were intended to reduce the risk of inadequate intakes of those nutrients. Fortification provides a food-based means for increasing intakes of particular nutrients and in some cases can be especially targeted to specific groups at risk of shortfalls in specific nutrients (e.g., infant formulas and infant cereals fortified with iron are useful to meet the high iron needs of older infants and young children).

In addition to fortification initiated by government authorities for public health reasons, independent voluntary fortification undertaken by private industry is also allowed in the United States. Often the amount of a nutrient added during such voluntary fortification may be based on commercial appeal, rather than public health analysis of desirable dietary additions. It is necessary to use highly fortified foods selectively when planning diets so that they contribute to nutrient adequacy without causing excess intakes. Canadian regulations are different and do not permit independent voluntary fortification. (For additional information, see Appendix D.)

Nutrient Supplements

Nutrient supplements provide an additional means of consuming specific nutrients that otherwise might be in short supply. Depending on their formulation, they may consist of single nutrients or a combination of many different vitamins, elements, or other nutrient and nonnutrient ingredients. Doses vary from levels close to the RDA or AI to several times these levels. Supplements are useful when they fill a specific identified nutrient gap that cannot or is not otherwise being met by the individual's food-based dietary intake. For example, it is recommended that women who might become pregnant obtain 400 μg of folic acid from the use of fortified foods or supplements, in addition to obtaining folate from a varied diet. For pregnant women, iron supplements may be suggested to meet needs for this nutrient that are unlikely to be achieved from food sources alone (IOM, 1992). However, there can be disadvantages associated with supplement use. For example, individuals at risk may not adhere to the supplement regimen. In other cases, those who are already consuming the RDA or AI for most nutrients from food sources may use supplements, but they will not achieve any recognized health benefit from consuming more of these nutrients as supplements and may be at risk of excessive intake.

Food and Supplement Labels in the United States and Canada

In the United States, the percent of Daily Values stated on food and supplement labels for vitamins and elements is based on the Reference Daily Intakes (RDI) established by the Food and Drug Administration. In the early 1990s, the term RDI replaced the term "US RDA" for vitamins and elements on food labeling. The current RDI values are the same as the US RDAs that were provided on food labels in the past, which are based on the highest RDA across the various age and gender categories (with the exception of pregnancy and lactation) from the 1968 RDAs (NRC, 1968). Additional RDI values have been added for nutrients for which there were no RDAs in 1968 (e.g., folate). Table 2-4 compares the current RDA or AI to the US RDI. An example of a U.S. food label is shown in Figure 2-4.

In Canada the food and supplement labels are based on the highest RNI for any age and gender group over age 2 from the 1983 Canadian RNIs (Consumer and Corporate Affairs Canada, 1988). Table 2-4 also compares the values used for the food label in Canada with the current RDAs or AIs. Canadian nutrition labeling has recently been revised, and the new label closely resembles the U.S nutrition label. An example of the new Canadian label format is shown in Figure 2-5.

Similar to the previously discussed situation with food guides, food labels also may not reflect the most current nutrient reference standards. Consumers need to be aware of the discrepancies that exist when using the food label information to plan their diets.

Dietary Guidelines in the United States and Canada

The U.S. Dietary Guidelines and Canada's Guidelines for Healthy Eating are designed to provide advice about dietary patterns that promote health and prevent chronic disease in a healthy population (see Appendix B). The dietary guidelines describe food choices that will help individuals meet their recommended intake of nutrients. Like the DRIs, the guidelines apply to diets consumed over several days—not a single day or single meal. Nutrient reference standards are not the primary focus of dietary guidelines, but when selecting healthy food choices based on the guidelines, individuals are more likely to meet recommended intakes of nutrients and to have macronutrient intakes that fall within the acceptable macro-

TABLE 2-4 Comparison of the Recommended Dietary Allowances (RDA) and Adequate Intakes (AI) with Daily Values (DV) for Vitamins and Minerals Used on Food Labels in the United States and Canada

Nutrient	RDA or AI[a]	U.S. Reference Daily Intake (DV)[b]	Canadian DV[c]
Vitamin A (μg)	900 RAE	5,000 IU	1,000 RE
Vitamin C (mg)	90	60	60
Vitamin D (μg)	15	10	5
Vitamin E (mg α-tocopherol)	15	30 IU	10
Thiamin (mg)	1.2	1.5	1.3
Riboflavin (mg)	1.3	1.7	1.6
Niacin (mg)	16	20	23 NE
Vitamin B_6 (mg)	1.7	2.0	1.8
Folate (μg)	400	400	220
Vitamin B_{12} (μg)	2.4	6	2
Pantothenic acid (mg)	5	10	7
Biotin (μg)	30	300	—
Choline (mg)	550	—	—
Calcium (mg)	1,300	1,000	1,100
Chromium (μg)	35	120	—
Copper (mg)	0.9	2	—
Fluoride (mg)	4	—	—
Iodine (μg)	150	150	160
Iron (mg)	18	18	14
Magnesium (mg)	420	400	250
Phosphorus (mg)	1,250	1,000	1,100
Selenium (μg)	55	—	—
Zinc (mg)	11	15	9

[a] Highest values for any age/sex category except pregnant/lactating. RAE = retinol activity equivalents.
[b] The U.S. DVs are higher than the recently recommended intakes (RDAs or AIs) for thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, pantothenic acid, biotin, chromium, copper, and zinc. The DVs are lower for vitamin C, vitamin D, calcium, magnesium, and phosphorus. It is not possible to directly compare vitamin A, vitamin E, and folate because the DV is in International Units (IU) while the RDA is in mg or μg and different bioavailability factors are incorporated into the values. There are three nutrients with an RDA or AI but no DV (choline, fluoride, and selenium).
[c] The Canadian DVs are higher than the RDAs or AIs for thiamin, riboflavin, niacin, vitamin B_6, pantothenic acid, and iodine. The DVs are lower for vitamin C, vitamin D, vitamin E, folate, vitamin B_{12}, calcium, iron, magnesium, and phosphorus. There are six nutrients with an RDA or AI but no RDI (biotin, choline, chromium, copper, fluoride, and selenium). RE = retinol equivalents, NE = niacin equivalents.

Nutrition Facts

Serving Size 1 cup (228g)
Serving Per Container 2

Amount Per Serving

Calories 250	Calories from Fat 110
	% Daily Value*
Total Fat 12g	**18%**
Saturated Fat 3g	**15%**
Cholesterol 30mg	**10%**
Sodium 470mg	**20%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

FIGURE 2-4 U.S. food label.
SOURCE: FDA (2000).

nutrient distribution ranges. For example, the U.S. guideline "Let the Pyramid Guide Your Food Choices" promotes dietary nutrient adequacy. The Canadian guideline "Enjoy a Variety of Foods" is based on the principle that foods contain combinations of nutrients and other substances that are needed for good health. Thus, an individual is more likely to meet nutrient needs by eating a variety of foods. The U.S. guidelines also emphasize choosing a variety of grains, especially whole grains, and consuming adequate servings of fruits and vegetables, which provide important nutrients that may be low among some population subgroups (e.g., pregnant women

Nutrition Facts
Per 1 cup (264g)

Amount	% Daily Value
Calories 260	
Fat 13g	**20%**
Saturated Fat 3g + Trans Fat 2g	**25%**
Cholesterol 30mg	
Sodium 660mg	**28%**
Carbohydrate 31g	**10%**
Fibre 0g	**0%**
Sugars 5g	
Protein 5g	
Vitamin A 4%	Vitamin C 2%
Calcium 15%	Iron 4%

FIGURE 2-5 Canadian food label.
SOURCE: Health Canada (2002).

and the elderly). The guidelines state that fruits and vegetables are excellent sources of folate and antioxidant nutrients such as vitamin C, vitamin E, and carotenoids, and thus help to prevent nutrient inadequacy. In addition, high intakes of fruits and vegetables are associated with reduced disease risk and are good sources of phytochemicals. The guidelines also serve to promote the importance of moderation and avoiding excess salt, fat, sugar, and alcoholic beverages. The guidelines, if followed, also ensure moderation in intakes of foods that provide energy but few nutrients.